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ABSTRACT

This guidebook on minimum course content for a study of statistical measures is designed to develop students' appreciation of the role of statistics in everday living. The primary emphasis is on activities centered on the collection and organization of data from daily happenings. Overall course goals are specified, a course outline and suggested teaching strategies are provided, performance objectives are listed and text references and a sample posttest are included. (JP)

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AUTHORIZED COURSE OF INSTRUCTION FOR THE QUINMESTER PROGRAM

PRACTICAL STATISTICS

5212.19; 5213.19; 5214.19

MATHEMATICS

DADE COUNTY PUBLIC SCHOOLS

DIVISION OF INSTRUCTION • 1971

SE 017 030

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QUINMESTER MATHEMATICS
COURSE OF STUDY
FOR
PRACTICAL STATISTICS
5212.19
5213.19
5214.19

Written by

William B. Allen

for the

DIVISION OF INSTRUCTION

Dade County Public Schools

Miami, Florida 33132

1971-72

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PREFACE

The following course of study has been designed to set a minimum standard for student performance after exposure to the material described and to specify sources which can be the basis for the planning of daily activities by the teacher. There has been no attempt to prescribe teaching strategies; those strategies listed are merely suggestions which have proved successful at some time for some class.

The course sequence is suggested as a guide; an individual teacher should feel free to rearrange the sequence whenever other alternatives seem more desirable. Since the course content represents a minimum, a teacher should feel free to add to the content specified.

Any comments and/or suggestions which will help to improve the existing curriculum will be appreciated. Please direct your remarks to the Consultant for Mathematics.

All courses of study have been edited by a subcommittee of the Mathematics Advisory Committee.

CATALOGUE DESCRIPTION

A study of the uses of statistical data. Includes construction of graphs from data collected and organized by students. Emphasis is on project work.

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OVERALL GOALS

The student will

1. Develop a basic understanding of the uses and misuses of statistics.
2. Develop an appreciation for the role of statistics in everyday living.
3. Have experiences in starting with a question or problem, deciding what data is needed, planning how to organize the data and then collecting and presenting the data.
4. Learn to read and understand statistical presentations such as graphs and charts.
5. Be encouraged to "follow through" on an extended project.
6. Improve skills in operations with rational numbers.

KEY TO REFERENCES
(*state-adopted)

B -- Brown, Kenneth E.; Snader, Daniel W.; and Simon, Leonard. General Mathematics: Book One. River Forest, Illinois: Laidlaw Brothers, 1963.

*L -- Lewis, Harry. Mathematics for Daily Living. Cincinnati, Ohio: McCormick-Mathers, 1970.

*AIM -- Johnson, Donovan A. and others. Activities in Mathematics: Statistics. Glenview, Illinois: Scott, Foresman and Company, 1971.

PERFORMANCE OBJECTIVES

The objectives identified by a P should be evaluated as part of the projects and notebook activities to be done by the student throughout the course and are not included in the posttest.

The student will

P-1. Recognize the use of statistics in magazines, newspapers, advertising, sales claims, and so on.

P-2. List specific applications of statistics indicating an understanding of how they are used.

3. Differentiate between inferential and descriptive statistics.

4. Use the counting principle to find the number of possible routes between two points, solve license plate problems and other simple counting problems.

5. Construct and use tree diagrams.

6. Determine the number of possible combinations of items under simple circumstances.

7. Make simple inferences from statistical data using the language of probability.

8. Compute and apply the mean, median and mode.

9. Indicate some understanding of the concept of a random sample by defining the terms random sample and population.

10. Demonstrate and understanding of the importance of lessening the bias in samples by picking out an obvious bias in a posed problem and indicating the possible effect it would have on the outcome.

11. Read and interpret frequency tables, bar graphs, broken line graphs, circle graphs, rectangular graphs and pictographs.

P-12. State the objective of the problem involved in a project simply and precisely.

P-13. Describe at least one method of selecting a random sample from a classroom.

P-14. Demonstrate an understanding of the effect of the size of the sample on the accuracy of predicting the characteristics of the population by using different sample sizes in repeated solutions of the same problem.

P-15 Demonstrate, through projects, the ability to accumulate data in at least three different ways.

P-16. Construct an appropriate graph or chart to present his data.

P-17. Collect a reasonably small random sample and make a valid generalization about the parameters of the population.

P-18. Find examples of misleading applications of statistics-especially in advertising and sales claims.

COURSE OUTLINE

(Scope and Sequence)

I. Introduction

II. Measures of central tendency

- A. Mode
- B. Median
- C. Mean

III. Basic probability

- A. Counting principles
- B. Making tree diagrams
- C. Determining the number of possible outcomes
- D. Relating probability and statistics

IV. Solving a statistical problem

- A. Formulation of the problem
- B. Selection of a sample
  1. Size
  2. Randomness
  3. Bias
- C. Accumulation of the data
  1. Questionaires
  2. Interviews
  3. Measurements
     a. Physical
     b. Test
  4. Experiments
- D. Organization and presentation of the data
  1. Frequency tables
  2. Bar graphs
  3. Broken line graphs
  4. Circle and rectangular graphs
  5. Pictographs

E. Generalization from the data

1. Inferences
2. Misleading applications

Performance Objectives	Course Outline
1, 2, 3	I. Introduction

State Adopted References

B p. 241

Teacher References

The page numbers below refer to the N.C.T.M. Twenty-Fourth Yearbook. It is strongly recommended that this book be obtained and used in teaching this course.

Suggested Strategies

1. The following should be included in the course introduction.

   A. What is statistics?

      Modern statistics is a method for solving problems which involve making decisions on the basis of incomplete information. It involves deciding how the problem should be approached, collecting pertinent data, organizing, presenting and interpreting the data.

   B. Types of statistics (pp. 280-281)

      1. Inferential
      2. Descriptive

   C. Uses of statistics

      1. Intelligence test scores
      2. Insurance rates
      3. Advertising and sales claims
      4. Public opinion polls
      5. Medical and scientific research
      6. Quality control in business and industry
      7. Gambling

   D. Importance of statistics (p. 273)

   E. Types of problems solvable by statistical methods (pp.282-284)

2. Students should begin collecting examples of statistical uses and misuses in magazines, newspapers, advertising, sales claims, and

so on, for class discussion and use. They should be recognized both in the graphical and in the printed form (i.e. 3 out of 5 doctors recommend...).

3. Differentiating between descriptive and inferential statistics should be emphasized in class discussion.

4. A bulletin board of examples of statistics found and collected by the students would be helpful.

5. Students should be encouraged to begin individual collections of examples found in the media to be added to a workbook containing the individual projects they will be doing later in the course.

Performance Objectives	Course Outline
8	II. Measures of central tendency A. Mode B. Median C. Mean

State Adopted References

B	pp. 241-258
L	pp. 507-513
AIM	pp. 15-26, 35-37

Suggested Strategies

1. This is a good opportunity for remedial work while computing means, medians and modes.

2. Classroom activities introducing simple projects such as finding median height of students and comparing to mean and mode heights can be used.

3. AIM: Statistics has 3 interesting games which could be played with regular cards in classrooms using other texts. Other projects are also suggested.

4. Lists of athletic scores, temperatures and other data from newspapers can be used to make problems more meaningful.

5. The effect of large and small scores on the mean in relation to sample size as well as the stability of the median and mode under circumstances should be discussed.

Performance Objectives	Course Outline
4, 5, 6, 7	III. Basic Probability A. Counting principles B. Making tree diagrams C. Determining number of possible outcomes D. Relating probability and statistics

State Adopted References

AIM pp. 1-14, 28-34, 53-64

Teacher References

NCTM p. 282 and Chapter 6
Berkeley, Probability and Statistics, An Introduction Through Experiments.
Alterman, Numbers at Work.

Suggested Strategies

1. Use road maps, simple number combinations for license plates, credit card and identification numbers as examples of simple counting problems. The social, legal and political implications of these should be included in classroom discussion (i.e. what numbers or letters on license plates indicate for different states, why different colors are used and so on).

2. Use tree diagrams to graphically represent the simplest problems.

3. Using examples such as the "guess test," sequence of heads and tails, or true-false sequences, impress on the students the number of differ different possible outcomes in what appears to be a simple circumstance.

4. The student should know what a statistic such as a batting average of 250 indicates and how it would be used.

Performance Objectives	Course Outline
P-12	IV. Solving a statistical problem A. Formulation of the problem

Teacher References

NCTM p. 286

Suggested Strategies

1. The importance of a specific definition or limitation of the problem to be solved should be discussed.

2. Examples for classroom discussion:

   A. Assume an inspector in quality control is told that he must "make sure not too many defective items come down the line, "too many" and "defective" must be clearly defined.

   B. The teacher assigns the problem, "Find the average height of the seventh graders." To which "average" is the teacher referring and which group of seventh graders (classroom, school, nation) should be considered?

Performance Objectives

9, 10, P-13, P-14

Course Outline

B. Selection of a sample
   1. Size
   2. Randomness
   3. Bias

State Adopted References

B p. 253
AIM pp. 65-67, 69, 87-88, 89

Teacher References

NCTM pp. 287-294

Suggested Strategies

1. Discuss the importance of sampling due to the impossibility of measuring the entire population or perhaps the destruction of the object as in quality control.

2. Demonstrate through examples how the statistic of the sample approaches the statistic of the population as the sample size is increased. Some discussion of the allowable margin of error that is acceptable should also be included here.

3. Define randomness as a method of selection in which each member of the population has an equal chance of being chosen.

4. An example of a partial page from the table of random numbers can be found in the Life Science Library: Mathematics, page 129 and in AIM: Statistics, page 89.

5. People tend to choose numbers from the middle of a given range rather than the ends. Thus, choosing numbers "by chance" can be shown to be an unacceptable method of sampling. As a classroom activity, assign each student a different number. Then have each student pick five numbers "at random" in the range of those assigned and show that the numbers are not chosen equally.

6. Methods other than simple random sampling such as cluster sampling, systematic sampling or stratified sampling should be demonstrated if the time is available.

Performance Objectives	Course Outline
P-15	C. Accumulation of the data 1. Questionaires 2. Interviews 3. Measurements a. Physical b. Test 4. Experiments

State Adopted References

AIM pp. 35-37 (project using interview method)
pp. 46-47
pp. 66-67, 69, 75 (projects using experiments)

Suggested Strategies

1. Questionaires are available from many outside sources. Discuss shortcomings (dishonesty in answering, non-returns, etc.), difficulty in writing, and difficulty in transferring and interpreting large quantities of data. Advantages would include ability to reach larger sample at less expense.

2. Interviews are oral questionaires. Common examples are opinion polls and telephone surverys. Importance of trained interviewer for accurate results could be demonstrated in classroom activities.

3. Controlled experiments are used in scientific research where one or two factors are varied and others remain constant. Simple science experiments could be included in classroom or assigned activities.

4. Outside speakers connected with quality control, university research, pollution control and environmental testing could supply valuable information.

Performance Objectives	Course Outline
11, P-16	D. Organization and presentation of the data 1. Frequency tables 2. Bar graphs 3. Broken line graphs 4. Circle and rectangular graphs 5. Pictographs

State Adopted References

B	pp. 240-295
L	pp. 513-537
AIM	pp. 17, 36-37, 46-48, 64, 88-91

Suggested Strategies

1. Avoid depending too heavily on textbook problems in Brown and Lewis. Emphasis should be placed on methods of presenting the students own data through the use of various types of graphs.

2. Projects should be organized to lend themselves to each of the various types of graphs. The same data may also be represented in more than one way.

Performance Objectives	Course Outline
P-17, P-18	E. Generalization from the data 1. Inferences 2. Misleading applications

State Adopted References

B	p. 241
L	pp. 529, 534
AIM	p. 67

Suggested Strategies

1. Discuss which inferences would be valid and which would not be valid based on the data accumulated.

2. Inappropriate methods of selection, misleading charts, misleading statements and inappropriate comparisons of results should be noted.

3. Examples of misleading applications by advertising and industry sales claims should be reexamined from those collected throughout the course.

PRETEST

Students entering this course should have an ability to perform operations involving non-negative rational numbers. A basic understanding of percent is also necessary.

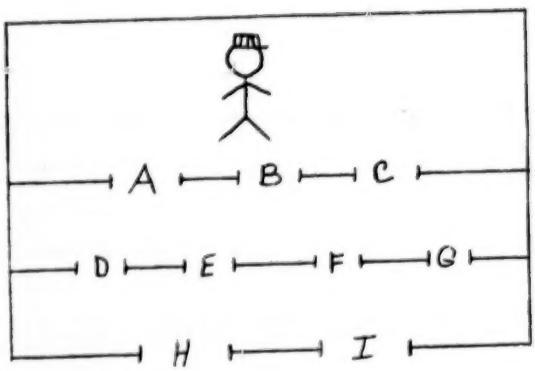
Weakness in these areas should be strengthened by inclusion of work throughout the course where appropriate, rather than by spending too much time on remedial work at the beginning. The primary objective of the course is to give the student a basic understanding of everyday statistics while strengthening his ability to operate with non-negative rational numbers.

POSTTEST-OBJECTIVE CORRELATION

Objective	Posttest items
3	28 - 33
4 - 6	1 - 6
7	7
8	8 - 27
9	40 - 41
10	34 - 39
11	42 - 61

SAMPLE POSTTEST ITEMS

I. Use the diagram at the right in answering the following questions.



1. How many different paths are there out of the maze?

2. Construct a tree diagram showing all possible routes.

II. Find the solution to each of the following problems.

3. On an option play, the quarterback can go either to the right or left and then he can pass the ball or run with it. How many different plays can he make?

4. An ice cream shop has 14 different flavors of ice cream, 6 different toppings and makes sundaes either with or without nuts. How many different sundaes can be made?

5. How many license plates with one letter and 3 digits can be made if zero cannot be used as the first digit?

6. In a class election, there were 3 candidates for president and 4 candidates for vice-president. How many possible election outcomes are there?

7. A baseball manager must make decisions based on descriptive statistics. Jim has a batting average of 250. Assuming Jim will be up to bat 4 times today, what is the probable number of hits he will get?

III. Compute the mean for each of the following sets of numerals.

8. 14, 7, 10, 8, 36, 11, 8, 21

9. 60°, 62°, 71°, 56°, 64°, 59°, 62°

10. 2.36, 4.72, 4.50, 1.25, 6.64, 3.75, 4.50

11. 3, $2\frac{1}{4}$, $1\frac{1}{2}$, 3, $5\frac{1}{2}$, $3\frac{3}{4}$, 5

IV. Find the mode for each of the following sets of numerals.

12. 40, 30, 25, 41, 36, 40, 41, 40

13. 59, 61, 58, 60, 61, 59, 62, 61, 60, 58

14. 3.3, 2.8, 3.6, 3.5, 2.8, 3.5, 3.5, 3.3

15. $6, 5\frac{1}{4}, 4\frac{1}{2}, 6, 8\frac{1}{2}, 6\frac{1}{2}, 8\frac{1}{4}$

V. Find the median for each of the following sets of numerals.

16. 18, 26, 31, 14, 17, 2, 43, 31, 27

17. 36%, 72%, 89%, 21%, 67%, 93%, 27%

18. $2\frac{1}{3}, 3\frac{1}{6}, 5, 4\frac{1}{2}, 1\frac{5}{12}, 3\frac{2}{3}, 3$

19. \$2.50, \$1.75, \$3.98, \$1.25, \$3.00, \$1.75, \$2.33, \$2.98, \$3.47

VI. Find the solution to each of the following problems.

20. Jack's golf scores for the first 4 rounds of the tournament have been 72, 76, 69 and 72. What must he get in the fifth round in order for his mean score to be 72?

21. The mode height of the 10 players on the Dolphin basketball team is 6'4". Bill Jackson, who is 6'6" tall, broke his arm and had to quit the team. What is the mode height of the remaining players?

22. Mr. Shipley's Marine Supply Store has 7 employees. The median weekly salary is \$120, the mode weekly salary is \$110, and the mean weekly salary is \$127. What is the total amount of Mr. Shipley's weekly payroll?

23. On a 10 point mathematics quiz, the scores of the 31 students were as follows:

Number Correct	Number of Students
10	5
9	9
8	5
7	7
6	4
5	3

What was the median number of correct answers?

24. A shoe department manager fills out his shoe order form based on past sales statistics. Which measure of central tendency will he find most useful in deciding how many of each size to order? Why?

25. A teacher must assign a grade based on 10 test and project scores. Which measure of central tendency will he find most useful?

26. In assigning test scores so that the same number of students receive A's as F's, the same number of students receive B's as D's, and the remainder receive C's, which measure of central tendency will the teacher find most useful?

27. Six families pooled their resources to buy a house in the Keys. They contributed the following amounts:

    $2000, $4000, $4000, $4000, $4000, $12,000

    Which measure of central tendency least describes a typical contribution.

VII. Using the letters I (inferential) and D (descriptive), indicate whether the following are examples of inferential or descriptive statistics.

28. A baseball player's batting average.

29. A figure representing the mean height of all the students in a ninth grade home room where each student was individually measured.

30. A figure representing the mean height of all the students in a ninth grade home room where a random sample of five students were selected and measured.

31. A graph showing how Jim Smith's allowance has been spent over the past six weeks.

32. A circle graph depicting the percentage of income spent on food, clothing, housing, insurance, savings and miscellaneous expenses for the typical American family.

33. An insurance company's life expectancy tables.

VIII. Using the letters R (random) and B (possible biased), indicate whether each of the following examples of sample selection is random or possibly biased.

34. Assign each member of the class a different number, putting the numbers in a hat, shake the hat and then draw numbers to choose a sample.

35. Assign each student a different number, and then choose five numbers between 1 and 30 to be used as the sample.

36. In making a political survey, select the persons to be interviewed from the phone book, using a random method of selection.

37. A door prize is to be awarded at a party. As each person arrives, he receives half a ticket with a number on it. The other half is put in a drum, the tickets are mixed and one is selected.

38. In making a survey of the average income of families in Coral Gables, all persons living on a corner lot are chosen as the sample to be interviewed.

IX. Answer the following questions.

39. In order to determine the mean grade point average for each eighth grade home room, the first 7 students to enter each room are chosen to be the sample. Why is this possibly a biased sample?

40. Define <u>random sample</u>.

41. Define the term <u>population</u> as it is used in inferential statistics.

X. The following set of temperatures were recorded as Seattle's maximum daily temperatures in degrees Fahrenheit for one month:

62, 74, 78, 86, 91, 87, 83, 68, 69, 88, 93, 77, 68, 72, 71, 86, 82, 91, 93, 88, 79, 83, 65, 69, 72, 76, 83, 88, 82, 89, 83

42. Construct a frequency distribution table for these temperatures.

43. Find the modal temperature.

44. Find the median temperature.

XI. Answer the questions using the Pictograph below.

WEEKLY ALLOWANCE RECORD

School lunches	○ ○ ○ ○ ○
Snacks	○ ◐
Entertainment	○ ○ ○
School supplies	◐
Savings	○

○ = 50¢

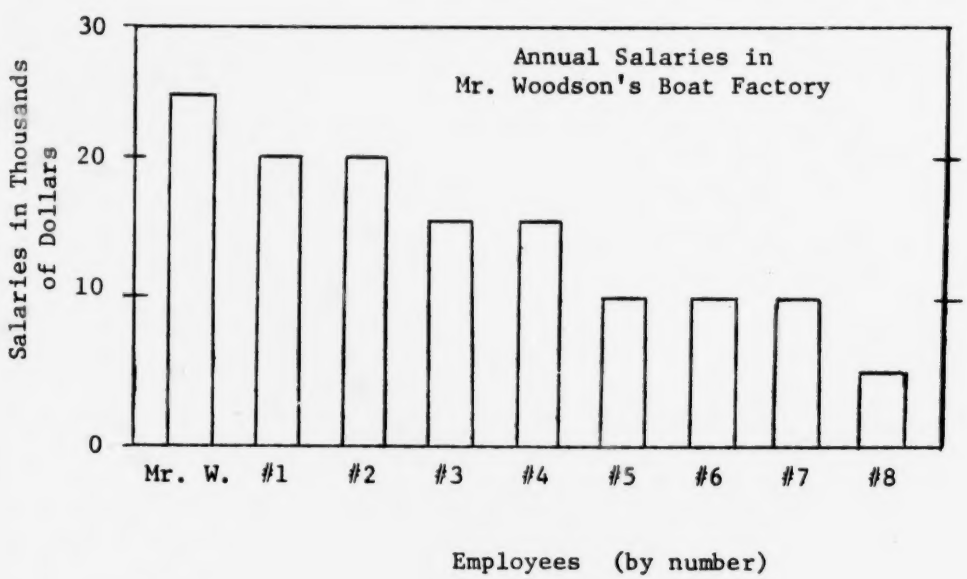
45. On which single itme does he spend the most?

46. How much does the student spend on entertainment?

47. How much does he spend for snacks?

48. What is his total allowance?

XXII. Answer the questions using the Bar graph below.



49. What is the mean salary?

50. What is the median salary?

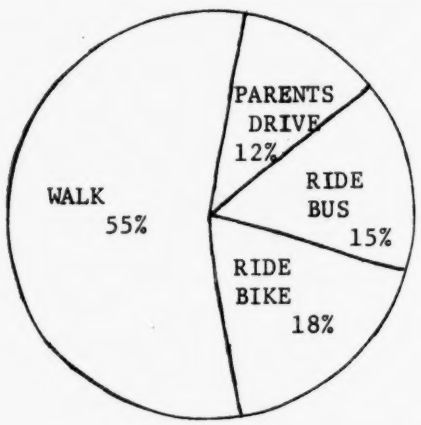
51. What is the modal salary?

52. How much does Mr. Woodson pay in total annual salaries?

XIII. Answer the following questions based on the Circle graph below.

Principal Methods of Transportation to School

Total Students = 2000



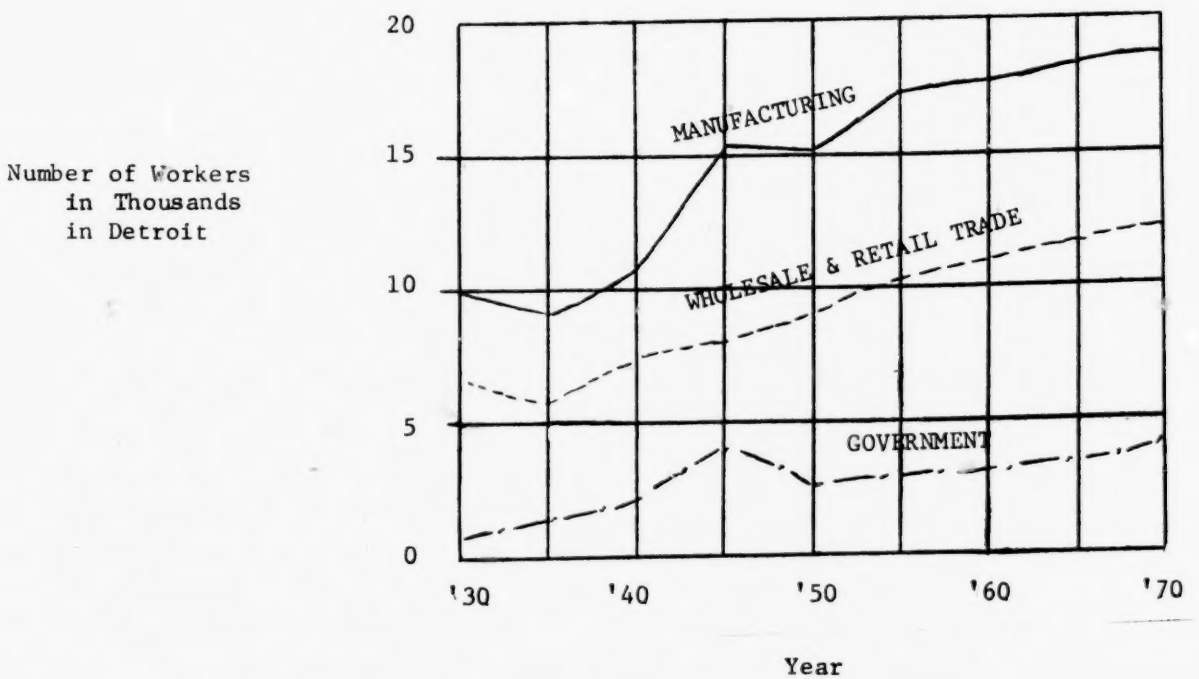
53. Which group is larger, the students who walk or the students who have some other method of transportation?

54. How many students ride the bus to school?

55. Approximately how many students walk to school?

56. What is the difference between the number of students who ride their bikes and the number whose parents drive them to school?

XIV. Answer the following questions based on the Broken Line graph below. Answers should be correct to the nearest 1000.



Number of Wage and Salary Workers in Manufacturing, Wholesale and Retail Trade, and Government in Detroit from 1930-1970.

57. What was the total number of workers in wholesale and retail trade in 1955?

58. What was the increase in the number of workers in manufacturing from 1940 to 1945?

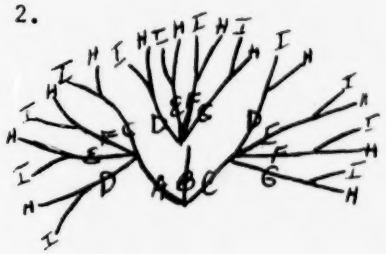
59. What was the total number of workers in 1960?

60. What was the difference in the number of workers in manufacturing and the number of government workers in 1965?

61. At about what year did the number of workers in manufacturing exceed 15,000?

KEY TO SAMPLE POSTTEST

1. 24

2. 

3. 4

4. 168

5. 23,4[illegible]

6. 12

7. 1

8. $14\frac{3}{8}$

9. 62

10. 3.96

11. $3\frac{3}{7}$

12. 40

13. 61

14. 3.5

15. 6

16. 26

17. 67%

18. $3\frac{1}{6}$

19. 2.50

20. 71

21. 6' 4"

22. $889

23. 8

24. mode

25. mean

26. median

27. mean

28. D

29. D

30. I

31. D

32. I

33. I

34. R

35. B

36. B

37. R

38. B

39. First students to enter room are apt to be better students.

40. Everyone in population has equal chance of being chosen.

41. That part of the total population or group of items from which the samples are taken and to which the results apply.

42.

TEMPERATURE	FREQUENCY
62	1
65	1
68	2
69	2
71	1
72	2
74	1
76	1
77	1
78	1
79	1
82	2
83	4
86	2
87	1
88	3
89	1
91	2
93	2

43. 83^{o}

44. 82^{o}

45. school lunches

46. $1.50

47. $ .75

48. $5.50

49. $1444.44

50. $15,000

51. $10,000

52. $130,000

53. walk

54. 300

55. 1,1000

56. 120

57. 10,000

58. 5,000

59. 32,000

60. 15,000

61. 1944

ANNOTATED BIBLIOGRAPHY
(Not on State Adopted List)

1. The National Council of Teachers of Mathematics. The Growth of Mathematical Ideas, Grades K-12, Twenty-Fourth Yearbook. Washington, D. C.: The National Council of Teachers of Mathematics, 1959.

   Excellent source for background and discussion material, course philosophy, approaches and experiment ideas. Recommend an effort be made to obtain this book as an essential teacher aid.

2. Clark, Ronald J. and others. Mathematics I. New York: John Wiley and Sons, Inc., 1966.

   Contains very helpful sections with problem and project ideas for both probability and construction of graphs.

3. School Mathematics Study Group. Mathematics For Junior High School, Volume I. New Haven: Yale University Press, 1961.

   Good source of information and problems on graphs and central tendency for teacher and student.

4. Berkeley, Edmund C. Probability and Statistics--An Introduction Through Experiments. New York: Science Materials Center, 1961.

   Comes with a kit which can be used as a convenience but is not necessary. Very good source of classroom activities and individual projects. Points out unexpected areas of sampling bias.

5. Alterman, Hyman. Numbers At Work. New York: Harcourt, Brace and World, Inc., 1966.

   A very good source on all aspects of probability and statistics to be included in this course. Helpful information and background material on sampling. Style makes it also an excellent student resource book.

6. Li[illegible] Scienc[illegible] Library. Mathematics. New York: Time Incorporated, 1963.

   Useful [illegible]oom aid for student interested in applications of [illegible]obabi[illegible]